

Questions and Answers

Would it be possible to use some sort of slingshot to achieve escape velocity from a planetary surface, lessening the need for propellant on the spacecraft?

—Beth Rackley, Poquoson, Virginia

Surface-based slings and orbiting tether facilities may be useful in achieving this goal. The principal limitation in launching a system that incorporates a tether from Earth's surface is that the mass of the tether and the associated dynamical control grow exponentially with the square of the required velocity change. Thus, a tether system usable for interplanetary propulsion would have to be very massive, with strength requirements in excess of those currently available.

Nonetheless, it is theoretically pos-

sible that tethers used as orbital slingshots could reduce rocket propellant requirements and be practical in the future. The orbital slingshot concept, which was pioneered by Italian celestial mechanician Giuseppe Colombo, uses a tether to deploy a payload already in orbit into a higher orbit (e.g., outward from the shuttle away from Earth). The payload is then sitting in the higher orbit, but with the velocity associated with the lower orbit—that is, with an excess velocity.

Kepler's law gives a different energy for each orbit—and using the tether changes the orbit. Once the payload is released from the tether, that excess velocity puts it into a higher orbit without the use of rocket propellant. Of course, power (hence energy) must be used to deploy the tether. Depend-

ing on the implementation of the tether power system, this might be a more efficient approach than ordinary propulsion. A surface-based sling on the Moon (or on any other body for that matter—although, say, on Earth the much larger gravitational mass and large air resistance make the idea impractical) could put a payload into a low orbit where it could be caught by a lunar orbiter. Such applications are clearly far in the future.

A tether concept was tested on a space shuttle flight in early August, 1992. The deployment had only gotten started when a snag developed in the process. The experiment was still encouraging to tether advocates, and they are proceeding with development and further experiments.

—JOE CARROLL, *Tether Applications*

Clementine Spacecraft Lunar Images

The tiny spacecraft Clementine (see the September/October 1993 issue of *The Planetary Report*) is now orbiting the Moon. The spacecraft captured these images of the Moon on February 19, 1994, with its ultraviolet (UV)/visible and high-resolution cameras.

The large crater at the lower left of the UV/visible frame is Nansen, which is 105 kilometers (65 miles) in diameter. Nansen's central peak shows up well in this image. In the high-resolution image, small craters down to about 100 meters (109 yards) in diameter are visible peppering Nansen's rim. This heavily cratered surface is fairly typical of the lunar highlands. The arrow in the UV/visible image points to the rim of a small double crater on Nansen's edge. This is the same area pointed to in the high-resolution image.

These images were taken very early in the lunar phase of the Clementine mission from an altitude of 1,572 kilometers (about 975 miles). Images: Naval Research Laboratory



UV/Visible Image



High-Resolution Image